

EXHIBIT C

Dr. Lisa Rodenburg

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3 PCBs: An Update

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5 PCB Webinar

6 September 25, 2017

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8 Transcription of DR. LISA RODENBURG

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Dr. Lisa Rodenburg

1 THE GENTLEMAN:

2 We are pleased to have Dr. Lisa
3 Rodenburg, professor of environmental
4 science at Rutgers University, as presenter.
5 Dr. Rodenburg is an expert on PCBs in
6 pigments and how they are dispersed into
7 the environment via their use in consumer
8 products. A lot of her work involves
9 using data sets that involve entire
10 watersheds to understand the sources and
11 fate of persistent organic pollutants.
12 So please welcome Dr. Rodenburg.

13

14 WEBINAR:

15

16 DR. RODENBURG:

17 Thank you. Hello everybody.
18 Thank you for joining us here today to
19 talk about PCBs.

20 I've been here at Rutgers for 19
21 years. In those 19 years I've spent
22 studying PCBs and other chemicals --
23 other chemical contaminants of the
24 environment. So I hope that you'll get

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1 something out of today's presentation.
2 It's intended, sort of, at the general
3 introductory level. But even if you know
4 something about PCBs, I think you'll find
5 some new information. Because I've tried
6 to update this with some of the new stuff
7 that's coming out about PCB sources and
8 toxicity.

9 So PCBs are Polychlorinated Biphenyls.
10 And so you can see the little blue picture
11 there of what a Polychlorinated Biphenyl
12 looks like. It's just two benzene rings
13 stuck together, and then that leaves ten
14 different positions open where you can
15 add a chlorine or more chlorines to the
16 benzene ring. So the PCBs can have up to
17 -- anywhere between one to ten chlorines.
18 And because those chlorines can be in
19 different positions in the ring, you end
20 up with the 209 different PCB molecules.

21 So the first lesson to learn from
22 this is that PCBs are not a chemical.
23 They are a class of many chemicals.
24 Again, there's 209 of them. And this is

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1 one of the reasons why measuring PCBs is
2 really tricky. It could be quite
3 difficult sometimes, because there's 209
4 different chemicals you're trying to
5 measure, and they're very similar in
6 structure and properties.

7 So a group of congeners that all
8 has the same number of chlorines is
9 called a homolog group. And in the
10 United States PCBs were sold under the
11 trade name Aroclor, by Monsanto. Monsanto
12 was the only -- virtually, the only
13 manufacturer of PCBs in North America.
14 And they sold them under the trade name
15 Aroclor. They had many, many uses. They
16 were used in electrical equipment,
17 primarily, including transformers and
18 capacitors. But they had many other
19 applications as well, which we'll talk
20 about in another slide or two.

21 They have a very high dielectric
22 property, which is what makes them great
23 in these electrical equipments. And
24 they're very flame-resistant, which was

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1 important. Because if you did have, for
2 example, a fire at an electrical substation,
3 it was really good that the PCBs were
4 flame-retardant. So that if all these
5 transformers and capacitors were involved
6 in a fire, the PCBs wouldn't light up.
7 You know, they wouldn't contribute
8 to the problem.

9 So the problem, of course, is that
10 PCBs were found to be toxic. And you
11 can, very legitimately, ask the question,
12 why were we selling a bunch of chemicals
13 that were toxic? Why didn't we not sell
14 them in the first place?

15 But, unfortunately, under the rules
16 at the time, the way that the law was written
17 in the United States, it was acceptable
18 to sell chemicals in commerce that were
19 toxic. And it wasn't until it was discovered
20 how toxic PCBs were that the U.S. Congress
21 moved a bill forward to ban them. And so
22 they were banned in 1976 under the Toxic
23 Substances Control Act, often called
24 TSCA. And at that point, their

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1 manufacture ceased and they stopped being
2 used. But because they're quite persistent,
3 here we are in 2017 still talking about
4 the problem with PCBs 30 years later.

5 So about 1.3 million metric tons
6 of PCBs were produced worldwide. It's
7 tough to really get a handle on that
8 number. But it's a big number. And the
9 problem with that number is, that means
10 that there's PCBs all over the United
11 States. PCBs can travel through the
12 atmosphere. They can travel with water
13 or soil particles. And so, unfortunately,
14 PCBs are present pretty much everywhere
15 in the United States.

16 So when PCBs were used, they had
17 -- some of them were used in what were
18 called open applications, meaning that it
19 was easy for the PCBs to get out of that
20 application and into the environment, and
21 that there were other applications that
22 were considered to be closed.

23 So the open applications were banned
24 first, obviously, because those were the

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1 ones that had the greatest potential to
2 release PCBs into the environment. And so
3 that you can see, it's a large list here;
4 flame-retardants, ink, adhesives. The
5 microencapsulation of dyes for carbonless
6 duplicating paper is a big part of the
7 reason why every recycle paper mill in
8 the United States has a big problem with
9 PCBs, because the PCBs were present in
10 this carbonless copy paper. And when
11 that paper gets recycled, the PCBs get
12 into the recycle paper stream; paints,
13 pesticides, plasticizers, all kinds of
14 stuff, surface coatings, metal coatings,
15 wire insulators. Every ship built by the
16 Navy that had any kind of wire in it,
17 which is every ship built by the Navy,
18 had PCBs in it. So when the Navy goes to
19 break down these old ships, they have to
20 do something about the PCBs. So those
21 open applications were banned in 1974.

22 The closed applications were
23 allowed to continue for a little bit
24 longer. That includes, again, capacitors,

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1 transformers, and the kinds of hydraulic
2 fluids that are contained within the
3 equipment. But, unfortunately, for example,
4 transformers, they do leak. They do leak
5 over time. And, certainly, transformers
6 that were built in the 1970s and contained
7 PCBs, if they're still in use, they're
8 getting pretty old. And, unfortunately,
9 that means that they are starting to leak
10 more and more. So even though these are,
11 quote, unquote, closed applications, they
12 do have the possibility of releasing PCBs
13 back to the environment.

14 So the problem with PCBs is that
15 they have the Trifecta of bad things.
16 Right? They are persistent, meaning that
17 they don't break down readily in the
18 environment. They're toxic. And they
19 bioaccumulate in organisms. And what we
20 mean by bioaccumulate is that as you go
21 up the food chain -- and that's what the
22 picture is intended to tell you -- at the
23 bottom you have the algae. Algae might
24 take up PCBs passively through just

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1 diffusion into the algae from the water.
2 But then when the shrimp eat the algae,
3 they take everything that was in all the
4 algae that they eat, and the PCBs in
5 algae stay in the shrimp's body. Even
6 though the rest of the material might get
7 pooped away, the PCBs stay in the organism's
8 body.

9 And so that as you move up the next
10 layer of the food chain, to the fish, and
11 then the seals, and then the polar bears,
12 they're taking large amounts of PCBs
13 consumed in the food and concentrating
14 them in one organism, and the fatty
15 tissues of one organism. So as you go
16 higher up the food chain, you build up
17 very high levels of PCBs.

18 So these three properties taken
19 together are what makes PCBs such a problem.
20 If they were toxic and bioaccumulative,
21 but they were persistent, maybe they
22 wouldn't be a big deal, because they
23 would have broken down by now. But it's
24 the fact that you have all three of these

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1 things going on in one chemical that makes
2 it such an issue.

3 So we've said many times now that
4 PCBs are persistent. But it is true that
5 they do have some pathways by which they
6 break down. The heavy congeners -- and
7 what I mean by "heavy" is that they have
8 a lot of chlorines on them. The heavy
9 congeners can get dechlorinated by bacteria.
10 Bacteria will pop off the chlorines. And
11 then once you remove a bunch of chlorines
12 and you get down to the congeners that
13 only have one or two chlorines on them,
14 then they can be degraded aerobically by
15 a bacteria. And they also then are more
16 volatile because they're less heavy. They
17 don't have all these chlorines on them
18 anymore, so they're liable to get into
19 the gas phase. And once they're in the
20 atmosphere, there are hydroxyl radicals
21 and other reactive species in the
22 atmosphere that will break down some of
23 the PCBs.

24 So there are some ways by which

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1 PCBs can be destroyed in the environment.
2 But they're just -- they're slow, compared
3 to the large volume of PCBs that's existing
4 out there. They're not fast enough to
5 really make a big dent in the amount of
6 PCBs circulating out there in the
7 environment.

8 So here's an example of the aquatic
9 food chain. And this is very similar to
10 the one I just showed where the polar bear
11 was the apex predator. But this is
12 making very clear that it's really human
13 beings that are the apex predator.

14 So in many of the environments
15 we're talking about, humans are the apex
16 predator, which means that humans can
17 develop very high levels of PCBs in their
18 body tissues. And that's one of the
19 reasons why PCBs are a problem.

20 So they're a problem for, you know,
21 human health. They're also a problem for
22 environmental health because the fish and
23 the birds, and all of these things, are
24 also being exposed to PCBs. So there's a

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1 range of environmental and health effects
2 that we have to worry about with PCBs.

3 So this is a couple years old now,
4 but I have no reason to think that the
5 picture has changed here. These are the
6 causes of impairment listed here under
7 the Clean Water Act for water bodies all
8 across the United States. So this is all
9 of the water bodies in the United States
10 that are considered to be impaired. This
11 is a list of one of the top reasons for
12 impairment. And you can see the first
13 few pathogens -- mercury, metals, nutrients,
14 low dissolved oxygen, sediment. And then
15 you get to PCBs.

16 So in terms of organic chemicals
17 that are problematic, in terms of their
18 environmental impact, PCBs really rise to
19 the top. They're the top driver of
20 toxicity and problems at superfund sites
21 all over the country, from the Upper
22 Hudson River superfund site, to the
23 Duwamish River, which I've been working
24 in lately, to the Portland Harbor

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1 superfund site, to the Houston Ship Canal.
2 All over the United States, PCBs are one
3 of the main causes for water quality
4 impairment and toxicity in harbors
5 and waterways all over the U.S.

6 So PCBs are toxic, as I mentioned.
7 In the last -- you know, since PCBs were
8 banned in the '70s, most of the focus,
9 when thinking about the toxicity of PCBs,
10 has been on the PCBs congeners that have
11 four or more chlorines. And the reason
12 that those were the focus is because
13 they're heavy, and that makes them very
14 hydrophobic. They like to stick to fatty
15 tissues. Therefore, they bioaccumulate
16 really readily in your body.

17 And so this list of things -- liver,
18 thyroid, dermal changes, immunological
19 alterations, neurodevelopmental changes,
20 meaning that they affect children -- and
21 children are exposed to PCBs through the
22 placenta and also through breast milk --
23 reduced birth weights, cancer. So there's
24 a lot of health effects. Most of the

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1 studies of these health effects is really
2 focused on the heavy congeners with more
3 chlorines. It's only in the last, maybe,
4 10 or 15 years that people have started
5 to think about the congeners with only
6 one or two chlorines. And it turns out
7 that those don't bioaccumulate, like the
8 heavy ones do. They tend to sort of pass
9 through your body and then pass right out
10 again. But that what we're discovering
11 is that that, alone, doesn't mean that
12 they're not toxic, and that they don't
13 have real bad effects. And so they can
14 get into your body. They can become
15 hydroxylated through the set of 50 system
16 (ph). And they can get hydroxylated
17 PCBs, which are really, really toxic.

18 So that the health effects of PCBs
19 run the gamut from the high molecular
20 congeners, to the low molecular congeners,
21 affecting many different organ systems in
22 the body, the immune system, the reproductive
23 system. And they have particularly bad
24 effects on children. And, again, children

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1 can be affected through breast milk and
2 through placental transfer.

3 And as we'll see toward the end of
4 this webinar, I'm going to spend a few
5 slides talking specifically about the
6 issue of PCBs at schools, because it's a
7 real big problem right now. It's
8 emerging as a big public policy problem
9 in the United States. So we'll talk about
10 that more towards the end.

11 So how do you get exposed? Most
12 people in the United States, their major
13 route of exposure to PCBs is the eating
14 of fish; fish that have been caught in
15 contaminated waterways. You know, when
16 you go to the store, you don't always know
17 where your fish are coming from. And
18 sometimes those fish have been caught in
19 contaminated waterways. And so you are
20 taking in PCBs as you're eating fish. And
21 for most people in the United States,
22 that is the major route of exposure.

23 Now, there are -- you can also be
24 exposed to PCBs through inhalation.

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1 Obviously, that's only going to be a problem
2 if you're, perhaps, working in a building
3 that was built with PCBs in the building
4 material. And, again, we're going to
5 talk about PCBs in schools toward the end.
6 So inhalation can be an important route
7 of exposure if you happen to work or live
8 in one of these buildings.

9 And there is the possibility for
10 dermal absorption. And, again, if you
11 happen to work in a building that's
12 contaminated, and you have children who
13 are running around and touching all the
14 contaminated caulk and adhesives and
15 things that were used to build the
16 building, they can absorb PCBs through
17 their skin.

18 The dermal absorption was also a
19 big problem with the carbonless copy
20 paper, because you know how people are
21 always touching their mouth and then
22 leafing through pages of documents. That
23 hand-to-mouth contact was resulting in a
24 lot of exposure of PCBs through carbonless

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1 copy paper.

2 So -- and the point here, toward
3 the bottom of the slide, is that because
4 -- I'm using the term here "POPS" --
5 persistent organic pollutants -- of which
6 PCBs are one type of persistent organic
7 pollutant, because they bioaccumulate, it
8 really doesn't matter how you're exposed.
9 Once the PCBs get into your body, they
10 stay there, and it's difficult to get rid
11 of them. So it doesn't really matter
12 what the route of absorption is. Once
13 they're in your body you are exposed; and
14 you're probably going to carry that PCB
15 burden around with you for the rest of
16 your life.

17 So in the United States, we have
18 federal water quality standards established
19 for the protection of human health and
20 the environment. And the federal water
21 quality standard for PCBs is 64 p/g grams
22 per liter.

23 Now, states are allowed to set
24 their own water quality standards. And

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1 if they can prove that, for example, the
2 PCB -- the people who live in that
3 watershed just don't eat very much fish,
4 then they can actually set a higher
5 quality water standard than that. That,
6 for example, is what happened in the Houston
7 Ship Canal area. They have a water quality
8 standard, 885 p/g grams per liter. But
9 in the Delaware River they did a fish
10 consumption survey, and it showed that
11 the people who live in the Delaware River
12 region eat a lot of fish, and so their
13 water quality standard is 64 P -- or,
14 excuse me. It's only eight p/g grams per
15 liter instead of the 64. So these can
16 change by location.

17 But this is a very, very low number.
18 In fact, this is almost unmeasurable, it's
19 so low. And we'll talk about analytical
20 techniques for measuring PCBs. And this
21 is a really low number that can be quite
22 difficult to measure. So that's just a
23 function of how toxic the PCBs are. The
24 amount that is considered, quote, unquote,

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1 safe in the water is such a low number
2 that you can barely measure it.

3 So here's an example of the Delaware
4 River. Remember that the federal water
5 quality standard is 64 p/g grams per liter.
6 But in the Delaware River, you know, you're
7 looking at 2,000 -- sometimes as much as
8 5,000 p/g grams per liter. And the
9 Delaware River is really not even that
10 contaminated, in terms of U.S. rivers.
11 It's kind of a more industrial, you know,
12 river in the United States. There are
13 other rivers that are much worse. So I
14 use the Delaware as sort of a general
15 example of the kind of thing you can
16 expect in any urban area.

17 So we are at least two quarters
18 magnitude away from being able to achieve
19 these water quality standards in many
20 urban areas of the United States. And
21 trying to bring PCBs concentrations down
22 by a factor of a hundred is really tough.
23 It's not easy to get 99 percent source
24 control. It's really difficult.

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1 So how do you measure PCBs? The
2 method that has been used the most and
3 has the longest history is called EPA
4 method 8082. It's been around since the
5 1970s. And any old documents that you
6 read of PCB measurements that were
7 conducted before the year 2000 would all
8 have been conducted using EPA method
9 8082, or something similar to it, and
10 uses gas chromatography. It's kind of an
11 old technology. It's been around for a
12 while. And, usually, when you measure
13 PCBs by method 8082, you're not -- you're
14 usually not trying to measure individual
15 congeners.

16 Remember we said there's 209
17 congeners? It's tricky to measure all
18 209. So instead, with this older method,
19 usually what they do is they measure
20 Aroclors. I don't know exactly what the
21 congener composition is, but it kind of looks
22 like Aroclor 1260, for example. And then
23 they'll report a number of concentration on
24 Aroclor 1260.

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1 The detection limits are in the
2 per billion range. And that 64 p/g grams
3 that I was talking about before, 64 p/g
4 grams per liter is in the part per
5 quadrillion range. So this EPA method
6 8082 couldn't get down low enough to even
7 measure the water quality standard that
8 exists these days. And round these days,
9 you know, it just depends on the lab that
10 you go to. But you can easily get method
11 8082 run in your samples for maybe \$200 a
12 sample. So it's not cheap, but it's not
13 ridiculously expensive.

14 There are some less sensitive methods,
15 and the main one is called ELISA. ELISA
16 is an acronym that stands for enzyme-linked
17 immunosorbent assay. And, essentially,
18 what you do there is you train the bacteria
19 to have an immune response to whatever
20 chemical you're trying to measure. And
21 they use ELISA kits for all kinds of
22 things; PCBs, dioxins, metal; all kinds of
23 things. You can train the bacteria to have
24 this immune response. And the immune

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1 response causes the bacteria to glow, and
2 then it's just a visual thing. It's a
3 spectrometer thing that you can just measure
4 the intensity of the light coming out of
5 your sample. It's quite cheap to do. It's
6 quick. It's kind of a quick and dirty
7 screening technique to see if you have a
8 PCB problem. It will measure total PCBs,
9 not individual congeners.

10 But the sum of all 209 PCBs could
11 also, in some cases, measure Aroclors.
12 But the detection limits are up in the
13 part per million range, so they're not
14 great. So this is really just a
15 screening tool. But the advantage is you
16 can see that it's, roughly, 20 bucks a
17 sample. So it's quite inexpensive. So
18 sometimes people use it as a screening
19 tool to rapidly test, you know, hundreds
20 of soil samples, for example, to try to
21 find where the hotspots might be, in terms
22 of PCB contamination.

23 So the new thing that's coming
24 along for the measurement of PCBs is the

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1 new EPA method 1668. That came out in
2 1999, and it has become pretty widely
3 adopted. EPA is requiring the use of
4 method 1668 at most of the big superfund
5 sites, and, you know, most of the sites
6 where PCBs are a big problem now. It
7 uses gas chromatography, but it uses a
8 high-resolution mass spectrometer.
9 High-resolution mass spectrometer is a
10 piece of equipment that costs about a billion
11 dollars. And you need to pay somebody
12 like \$80,000 a year just to run it; keep
13 it running effectively. So it's a very
14 expensive piece of equipment. But it can
15 individually measure most of the 209
16 congeners. You can measure all of them.
17 It's just that some of them coelute (ph)
18 with others. You put them together and
19 say, well, this peak in the chromatogram,
20 it's these five congeners together. And
21 I don't know how much of that peak is
22 congener A, versus congener B. But it
23 does much better, in terms of measuring
24 individual congeners than the old 8082

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1 method.

2 And, you know, the big advantage
3 is, the detection limits are now getting
4 down into the part per quadrillion range.
5 So that's the range where you can now
6 actually measure PCBs down at the range
7 where the water quality standard has been
8 set. But the problem is, it's expensive.
9 It's like \$900 per sample, depending
10 on -- again, you can probably shop around
11 and get a cheaper contract lab. But a
12 good contract lab will charge you about
13 \$900 per sample.

14 And by the way, not all contract labs
15 can do a great job with this method. Some of
16 them will take your money and then give you
17 some data that's not so great. So it's
18 worth it to pay the money and get a good,
19 reliable contract lab.

20 The invention or the development
21 of method 1668 really was a game changer,
22 because now we can start to measure PCBs
23 in places where we didn't even think
24 there were PCBs before. We can get a lot

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1 more information about what the sources
2 are because we can look at individual
3 congeners. And, you know, for me, as a
4 environmental chemist, I feel that's a
5 great thing. I'm really happy about it.
6 But, you know, if you're running a
7 contaminated site, you might not be so
8 happy, because now you're suddenly
9 finding contamination everywhere. You
10 were hoping maybe it was localized to one
11 place on the site. So instead of the
12 two-edge sword, method 1668 has really
13 changed the way people measure and think
14 about PCB contamination.

15 And it's really important to point
16 out that the old Aroclor method -- this
17 is data from the Hudson River, from the
18 U.S. Army Corps of Engineers. And they
19 did a subset of samples. There's maybe
20 30 samples here where they measured PCBs
21 in the sample using the Aroclor method,
22 the 8082 method, and, also, using the
23 1668 method. And when you plot one
24 versus the other, it's not a great

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1 agreement between the two methods. The
2 R-square is only .4. And the slope is
3 not 1. So if these two methods were
4 giving you exactly the same data, the
5 slope would be 1, the intercept would be
6 0, and the R-square would be, you know,
7 .9.

8 So there's a lot of disagreement.
9 And that's pretty upsetting, because in a
10 place like the Upper Hudson River, General
11 Electric has spent half a billion dollars
12 -- billion with B -- dredging the river,
13 based on data that, you know, we're
14 not really sure how accurate it is.

15 Okay. So as I mentioned, you have
16 all these individual congeners. And on
17 this particular plot, those are shown
18 across the bottom. You know, 8+5 means
19 PCB 8, plus PCB 5. I can't separate the
20 two, so I'm just going to quantify them
21 together. And then on the wide axis,
22 you have the percent in the Aroclor. And
23 this is a plot for Aroclor 1254. It's
24 one of the many formulations that

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1 Monsanto was manufacturing.

2 And so the first point is, you see
3 how there's sort of a Gaussian distribution
4 here. We have a lot of high bars in the
5 middle, and low down at the end. And in
6 this plot, the numbers are listed from
7 the lowest number to highest number. And
8 the way the numbering works is, the lowest
9 number has only one chlorine, and the
10 highest number of PCB 209 has ten chlorines.
11 So as you go from left to right, you're
12 increasing the molecular weight of the
13 congeners, and you're increasing the total
14 number of chlorines on the molecule.

15 So Aroclor 1254 has, you know, kind
16 of this rough distribution PCBs, mostly
17 PENTA, you know, PCBs with five chlorines
18 on them. And what I'm trying to point out
19 here is that the size, the number of
20 chlorines on the molecule, has a big impact
21 on the physical properties of the chemical.

22 So PCBs with only one or two
23 chlorines, they're lighter in the sense
24 that their molecular weight is lower.

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1 And, therefore they're quite volatile.
2 Their paper crushes are pretty high. They
3 can volatilize in the gas phase and blow
4 away with the wind. They're less likely to
5 bioaccumulate because they're more soluble
6 in water. You can remove them from your body,
7 through your urine, for example, and they're
8 not as liable to stick to your fatty tissues;
9 whereas on the other end, the heavier
10 congeners with more chlorines, they would
11 prefer to stick to solids or to fatty
12 tissues. They're not going to, particularly,
13 be in the gas phase. So it's important
14 to understand that, you know, again, you
15 have 209 congeners, and they run the gamut,
16 in terms of their physical and chemical
17 properties. Some of them are quite
18 volatile. Some are then are very, very
19 hydrophobic and stick to fatty tissues.

20 So the main sources of PCBs in
21 most watersheds in the United States are
22 the Aroclors that were produced by Monsanto.
23 Their fingerprints can change a little
24 bit, so sometimes it's hard to identify --

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1 you know, if it started out looking exactly
2 like the Aroclor, and then over time it
3 might change a little bit and doesn't
4 exactly look like the Aroclor anymore,
5 but that is the main source. Because,
6 you know, as we said, 1.3 million metric
7 tons of PCBs produced -- it's a lot of
8 PCBs out there in the environment. Most
9 of those were produced intentionally for
10 sale on the market. But there are a
11 couple of sources of PCBs that have
12 started to become proportionally slightly
13 more important over time. Because over
14 time, all of these Aroclor-type PCBs are
15 slowly exiting our environment. One way
16 or another, they're slowly being buried
17 in deep sediments of the ocean or they're
18 volatilized and blow away with the wind.

19 And so the overall levels of PCBs
20 in the environment are dropping. And as
21 the Aroclor-type PCBs are starting to go
22 away, we're starting to be able to see,
23 more and more, some of the non-Aroclor
24 sources. And many -- I'm going to talk

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1 about what some of the categories of
2 non-Aroclor sources are. But a lot of
3 them have to do with different pigments.

4 I mentioned earlier that there is
5 one method by which PCBs can be destroyed
6 in the environment, and that is through
7 bacteria that like to remove some of the
8 chlorines. And so if you go out looking
9 for a PCB source, you might find something
10 that looks like a dechlorination signal.
11 It's the product of the dechlorination in
12 these PCBs and bacteria. And so it doesn't
13 look like the original Aroclor anymore.

14 Now, it probably started out life
15 as an Aroclor, because that's what the
16 bacteria were feeding on. But it has
17 altered its fingerprint. It looks very
18 different than it did from the original.

19 So we're going to talk about each
20 of these in turn. As I mentioned, the
21 Aroclors -- Aroclor was a trade name used
22 by Monsanto. It was the only North
23 American producer of PCBs. And it produced
24 a whole number of different formulations

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1 with different numbers. I mentioned 1254
2 in that previous slide. They also
3 produced 1242 and 1260. And the numbering
4 convention was that the 12 stood for the
5 12 carbons on the PCB molecule, and then
6 the 42 or the 60, or whatever, stood for
7 the percent of the formulation that
8 considered the chlorine by weight. So
9 they would take a big vat of biphenyl and
10 add throw away the 42 two percent
11 chlorine and let it all react. And then
12 that would be their Aroclor 1242.

13 And then later on, when it started
14 to become clear that PCBs were
15 environmentally problematic, they dreamed
16 up something called Aroclor 1016. And
17 that name doesn't really have any meaning.
18 But it was very, very similar to Aroclor
19 1242 except that they tried to remove some
20 of the higher molecular weight congeners
21 because they knew some it was bad.

22 So those are some of the typical
23 Aroclor names that you might run into if
24 you're, for example, looking at a

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1 contaminated site, or something. You
2 might run into these.

3 So these PCBs produced by Monsanto,
4 as I mentioned, they were used in all
5 kinds of consumer products and transformers
6 and capacitors, and carbonless copy
7 paper, and building materials. So
8 they've dispersed all over the environment.
9 And every city in the United States has
10 some kind of PCB problem. To a greater
11 or lesser extent, we've all got PCBs;
12 every city in the U.S. And some cities,
13 especially on the West Coast, have spent
14 fair amounts of money trying to combat
15 PCBs. And they have decided that they
16 shouldn't have to pay for that. And so
17 they have sued Monsanto over its
18 production of PCBs. And that includes,
19 you know, again, Spokane, Portland, a
20 bunch of cities in California, and the
21 entire state of Washington.

22 So this is kind of a new development.
23 I believe that this came about in the
24 last two years or so. And so that's a

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1 pretty big change. In the past, I think
2 Monsanto had kind of gotten away with it,
3 to some extent. But now there's these
4 different lawsuits pending.

5 So here's an example of what the
6 different Aroclors look like. These are
7 the four big ones. Remember, I mentioned
8 that Aroclor 1016 looks a lot like
9 Aroclor 1242. So they're very similar.
10 So I've lumped those together. And then
11 there was Aroclor 1248, 1254 and 1260.
12 So these five Aroclors made up 99 percent
13 of all the U.S. production.

14 There are a couple of others.
15 There's Aroclor 1268 and 1272. But those
16 are very, very minor, rarely used; not
17 the kind of thing that you're typically
18 going to run into when you're doing any
19 kind of site assessment or thinking about
20 PCBs.

21 So this is what they look like.
22 And you can see that Aroclor 1242 was
23 only 42 percent chlorine by weight. So
24 its congeners were kind of bunched up there

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1 on the left, because those are lower
2 molecular weight; whereas Aroclor 1260,
3 you know, was 60 percent chlorine by weight.
4 So it has a lot more of the heavy congeners.
5 So they're all the way over there on the
6 right with the really heavy stuff.

7 And the point here is that if you
8 do measure all these individual congeners
9 and then plot them up in a graph like
10 this, you can compare what you're measuring
11 out of the environment to what was
12 measured in the original Aroclor samples.
13 And you can get a pretty good idea of
14 what Aroclor it is that's out there in
15 the environment.

16 And then based on knowing on which
17 Aroclors were used for which types of
18 applications, which industries, then you
19 can start to figure out who's responsible for
20 the PCB contamination that you're seeing
21 in your local waterways.

22 I mentioned that the PCB congener
23 patterns can change a little bit over
24 time. And there's a number of ways that

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1 this can happen; through evaporation,
2 condensation of PCBs that volatize in the
3 air and then condense it back down.

4 And one of the other ways that
5 they do get altered is by the organisms.
6 So if these PCBs get into the fish, for
7 example, this plot here is supposed to show,
8 on the bottom, just a regular -- the blue is
9 what was measured in some tissue samples.
10 This is from Washington State, I believe.
11 And the orange is the Aroclor, the original
12 Aroclor, unaltered. And you can see in
13 the bottom figure, the blue and the
14 orange bars really match up really,
15 really well. But then on the top figure,
16 the blue bars and the orange bars,
17 there's places where they really don't
18 match anymore. And I've tried to circle
19 some of those.

20 What's happening there is that
21 organisms go after very specific targeted
22 PCB congeners that, for whatever reason,
23 fit perfectly into the enzyme and just
24 get destroyed. And so some of the PCBs

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1 get left behind. But a few of them just
2 get almost completely removed.

3 I know that the chart here is very
4 hard to see. But one of the ones that
5 gets removed is PCB 1247 and 172. Things
6 like that, they just disappear. So you
7 can get very systematic alteration of the
8 congener fingerprints when you're in
9 BYOTA (ph). And if you know what to look
10 for, you can relate those fingerprints
11 back to the original Aroclors. And, again, that
12 can give you an idea of who might have
13 been responsible for the PCB contamination in
14 your system. So that's what I'm going to
15 say about Aroclors. The other big
16 source of PCBs in the environment are
17 these non- Aroclor sources. And under
18 the Toxic Substances Control Act, the
19 inadvertent production of PCBs was
20 allowed. So if you were running some
21 sort of chemical process and it had,
22 maybe, chlorine in it, and it had some
23 kind of carbon in it, you know, you put
24 chlorine and carbon together in a

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1 chemical reaction, you're going to get
2 some PCBs as a bi-product. And EPA
3 recognized that. And they made no
4 attempt to ban every process in the world
5 that might accidentally produce PCBs.

6 So PCB concentrations in the
7 products have to average less than 25
8 parts per million. And, remember, 25
9 parts per million is a high number.
10 Remember back to that slide about
11 measurement methods? That's the kind of
12 concentration that you can measure just
13 using one of the ELISA kits. This is a
14 high concentration. So the average has
15 to be less than 25 parts per million, and
16 no individual sample can be higher than
17 50 part per million. 50 parts per million
18 is a big number for PCBs. If you find
19 anything in the world, anything that you
20 measure that comes up as higher than 50
21 part per million PCBs is suddenly considered
22 toxic waste and must be remediated. So
23 this is a big number that you see again
24 and again when you're talking about PCBs.

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1 But under TSCA, they did something
2 a little odd. They put in these discounting
3 factors. If the PCBs in your formulation
4 only had one chlorine, so they were
5 monochlorobiphenyls, then you can take
6 those concentrations and divide them by a
7 factor of 10. So, in other words, you
8 can have an average of 250 parts per
9 million, as long as it was just these
10 monochloro PCBs. And if you only had two
11 chlorines on your PCB molecule, you'd get
12 to discount the concentration to five.

13 It's kind of an odd thing to do.
14 I think the reason they did it is because
15 they figured that those monochlorinated
16 PCBs are a little less toxic and probably
17 don't accumulate as much, so maybe they're
18 not such a big deal. But it does lead to
19 kind of a strange formulation for how you
20 calculate whether your product is meeting
21 or exceeding the standards.

22 But the important point again is
23 that TSCA didn't ban this. This was all
24 allowed under TSCA. And as it turns out,

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1 there's a number of chemical processes
2 that do produce PCBs. Any different
3 organic and color pigments, have PCBs in
4 them, especially the diarylide yellows.
5 Diarylide yellow is one of the most
6 commonly-used pigments in the world. If
7 you remember your home color printer,
8 it's got a yellow, a pink, a blue, and a
9 black cartridge in it. And that yellow
10 in your home printer is diarylide yellow.
11 It's a very, very common pigment used
12 worldwide.

13 Another pigment that contains PCBs
14 -- under some circumstances can contain
15 PCBs -- is titanium dioxide. That's the,
16 bright, bright white pigment that's used,
17 for example, in every batch of paint in
18 the world. You go to Home Depot and you
19 buy white paint. It's made white with
20 titanium dioxide. And then they add
21 different pigments to it to make it the
22 color you want. And those can contain
23 PCBs 206, 208, 209. Again, remember the
24 numbering convention. Those are big,

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1 heavy congeners with a lot of chlorines
2 on them.

3 And then it turns out that some
4 silicone rubber tubing products also can
5 have PCBs in them. And one of the
6 take-home messages there is that if you
7 are asked to do any sampling for PCBs,
8 don't use silicone rubber tubing to do
9 the sampling. Unfortunately, this has happened
10 too often, that people went out and did
11 water sampling, and they used silicone
12 rubber tubing to collect their samples,
13 and the samples became contaminated with
14 PCBs.

15 So this is an example of -- this
16 is the work we did in my lab, where we
17 went and we just took samples of newspaper and
18 cardboard and magazines and all kinds of
19 things. And we measured the PCB-11 in
20 them. And we found them everywhere we
21 looked; or almost everywhere we looked. And
22 that was all stuff from my recycling bin
23 at home.

24 Then we asked all of our friends,

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1 whenever they traveled, to bring us home
2 some paper samples that we could test.
3 And so you can see, kind of, the middle
4 of that figure, there's paper from Georgia
5 and Moldova and China and Costa Rica.
6 And for some reason, the Netherlands had a
7 really high hit for PCB-11.

8 So all over the world, these pigment
9 markets or global markets, most of the
10 pigments are produced in India and China,
11 and then they're sold all over the world.
12 So everywhere you go you're going to find
13 this PCB-11.

14 In the four printing process that
15 I talked about in your home printer, that's
16 the same process that's used to print
17 T-shirts and things. So we went and we
18 measured PCBs in some T-shirts and some
19 fabric material that were printed with a
20 design on the right, and then some that
21 had no design on them on the left. And
22 you can see those that had a printed
23 design -- unfortunately, Sponge Bob had,
24 you know, a yellow pigment and he had a

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1 lot of PCB-11 in there.

2 So the point is that these PCBs
3 are everywhere. I mean, they're all
4 over. In every paper sample that you
5 have, every color, anything that's color
6 printed, all of these fabric material,
7 everywhere in the world they've got some
8 low level of PCBs in them.

9 And we did some leaching tests.
10 And the PCBs do leach out quite readily.
11 So when you wash your clothing, for example,
12 PCBs in the pigments are going to get out
13 into the waterways. So that's one other
14 source of PCBs that's, you know, worth it
15 to be aware of.

16 And then the third, not exactly
17 source, but process, by which PCBs can be
18 produced, is microbial production of PCBs
19 by bacteria. And it used to be that we
20 thought this only happened in aquatic
21 sediments. Like the Upper Hudson River
22 was the big example of where bacteria in
23 the Hudson River had been dechlorinating
24 PCBs for years. Ever since General Electric

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1 has been dumping PCBs in the Upper Hudson
2 River, the bacteria has been going after
3 them. But we found more recently that it
4 can also happen in places like sewers and
5 landfills and in contaminated groundwater.

6 So you can find these dechlorinated
7 PCB signals in a lot of other places. And,
8 usually, the bacteria -- I won't bore you
9 with all the different species' names and
10 stuff. But the bacteria that do this,
11 for some reason they can remove the PCBs
12 on the outer part of the ring, the meta
13 and para positions, if you're looking at
14 that figure on the lower left. Those
15 outer positions, they can remove those
16 borings (ph). For some reason, they
17 can't get into the inner locations, the
18 two and six positions. And because of
19 that, you get some very characteristic
20 end products. Like, the molecule that's drawn
21 there on the right, that is PCB Number 4.
22 It's got two chlorines, both of them in
23 the two position. So we call it two, two
24 prime, dichlorodiphenyl. Characteristic

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1 end products of dechlorination.

2 So if you do get 1668 data rolling
3 across your desk, and you see a bunch of
4 PCB-4 in it, now you know where it comes
5 from. And this is an example of all of
6 the different places in the world where
7 we have seen some dechlorination happening;
8 the Delaware River, the different dischargers,
9 so the sewers and the landfills.

10 And there was dechlorination
11 happening in the New York-New Jersey Harbor.
12 That's dechlorination happening in the
13 Upper Hudson River, and flowing downstream.
14 The dischargers in the New York Harbor
15 region also showed dechlorination in the
16 landfills and sewers. The Portland Harbor
17 superfund site, in Portland, Oregon, had
18 a ton of dechlorination going on in the
19 groundwater. We also found this in
20 wastewater from Washington.

21 So the point is that this is
22 happening all over the place. So if you
23 are seeing some strange congener patterns, if
24 someone is asking you to look at some

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1 method 1668 data, and you're wondering
2 what the heck it is, that could be what
3 it is.

4 Okay. So I'm going to talk about
5 a couple different case studies and try
6 to give you an overview of different places
7 throughout the United States where PCBs
8 are a problem and highlight some of the
9 issues here. First we're going to talk
10 about the Hudson River.

11 I know a lot of you guys are -- a
12 lot of the people watching are local.
13 You're from the New York-New Jersey area.
14 And so you probably are already aware
15 that the Hudson River is one giant superfund
16 site. For about 30 years, ending when
17 PCBs were banned in 1977, General Electric
18 was discharging PCBs into the Upper Hudson
19 River. And it flows from there, from those
20 two plants up in Glens Falls. It flows
21 about 200 miles downstream to New York
22 City. And that entire stretch is a big
23 superfund site.

24 There was a Record of Decision,

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1 meaning that the judge in the case
2 decided on what the remedy would be to
3 clean up the river. Under that Record of
4 Decision, the remedy was that GE had to
5 dredge portions of the Upper Hudson
6 River, meaning that they dredged the
7 sediment out. And in the case of the
8 Upper Hudson River -- I've never heard
9 his happening anywhere else. But in the
10 case of the Upper Hudson River, when they
11 dredged and they brought up this sediment
12 from the bottom of the river, they found
13 pure liquid PCB oil in the river. That's
14 how contaminated it was. They were
15 dredging up all of this contaminated
16 sediment. They typically -- what often
17 happens in these kinds of dredging
18 operations is that the dredging material
19 comes up in what they call black
20 mayonnaise. It's real runny, and it's
21 very difficult to do anything with it
22 because it just runs through your fingers.

23 So what they do is, they add cement
24 to it to tighten it up and make it more

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1 solid so that they can actually work with
2 it. So they stabilize it with cement.
3 And then they pack it into rail cars, and
4 they ship it off to some landfill somewhere
5 that has agreed to take it.

6 And, you know, to me, that sounds
7 kind of crazy. There's no treatment.
8 There's no attempt to treat the sediment
9 to make it any better. You're just packing
10 it away in a landfill and forgetting about
11 it. But that is the state of the art,
12 unfortunately, when it comes to dredging
13 contamination.

14 So GE has done the dredging. The
15 dredge is now complete. The EPA is saying
16 that now we need -- under the superfund
17 rules, you evaluate the remedy every five
18 years to decide whether it has worked or
19 not. And EPA is doing their five-year
20 reviews and has decided that it's too
21 soon to tell whether the remedy has
22 actually worked yet. But the NOAA, the
23 National Oceanic and Atmospheric
24 Administration, which oversees the Fish and

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1 Wildlife Service is disputing whether the
2 dredging has been enough. And there's
3 been a dust up going on between the EPA
4 and NOAA.

5 There's also a natural resource
6 damage assessment underway where the
7 trustees, which are the Fish and Wildlife
8 Service, NOAA, and the New York State
9 Department of Environmental Conservation,
10 they are trying to recover damages from
11 General Electric to pay for the
12 restoration of some of the natural
13 resources in the Hudson River.

14 And as I mentioned before, the
15 Upper Hudson River is one of the few places
16 on earth where we know that bacteria were
17 really going after PCBs and trying to
18 destroy them. That's where we first
19 learned about it, where we learned much
20 of what we know about dechlorination
21 coming out of the Hudson River. But it's
22 important to know all of that
23 dechlorination was not enough to prevent
24 GE from having to spend half a billion

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1 dollars dredging the river. So
2 dechlorination is nice, but usually it's
3 not enough to fix whatever the
4 environmental contamination problems are.

5 So this is just some work that we
6 did, showing how the sources of PCBs to
7 the Lower Hudson River -- so this is below
8 the Troy Dam -- the Upper Hudson River
9 flows into the Lower Hudson River. And
10 this is just showing how the sources to
11 the Lower Hudson River have changed over
12 time.

13 I think the most interesting part
14 of this is the right-hand panel. You
15 take a sediment core. You stick a tube
16 down into the sediment, and when you
17 bring it back up it's full of sediment.
18 And you cut it and measure the PCBs and
19 also other chemicals in each of those
20 different layers. And if you've taken a
21 good core, then the layers were set down
22 very evenly.

23 In the New York-New Jersey Harbor,
24 that sedimentation rate is about a

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1 centimeter of sediment depositing every
2 year. And so you can estimate how old
3 these different layers are. And so where
4 you see the big max of PCB concentration,
5 we believe that that was 1977, when PCBs
6 were banned. Because they were going
7 gangbusters right up until the very end.
8 So the highest concentrations were
9 probably right around 1977 and then they
10 fall off. And the orange dot there, the
11 maximum, that's actually Aroclor 1248,
12 which is not what GE was using. GE, in
13 the Upper Hudson, was using Aroclor 1242.

14 So the thing I find interesting
15 about this is that everybody was using
16 PCBs up until 1977. It's not just
17 General Electric. These were all coming
18 from New York City and the surrounding
19 area. And the main source of PCBs to the
20 Lower Hudson River to this point was all
21 this urban stuff coming out of the city.
22 But then after that, in 1977, you can see
23 that that stuff falls away really quickly
24 and it disappears. But the blue dot,

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1 which is the stuff coming from the Upper
2 Hudson River, the Aroclor 1242, which GE
3 was using, it falls off more slowly. So
4 that these days, at the top of that
5 core -- this core was collected in 2002.
6 So in present day, the Upper Hudson River
7 is the biggest source of PCBs to the
8 Lower Hudson River now because other
9 things have kind of been taken out of the
10 equation. The other stuff has washed
11 away from the system.

12 Here's another example. This is
13 Spokane County, Washington. I did some
14 work with them trying to track down PCBs
15 in their wastewater treatment stream.
16 And the top figure is showing the PCB
17 congeners in their influent; what's coming
18 into their wastewater treatment plant.
19 And they're kind of roughly ordered from
20 the most abundant congeners on the left,
21 to the least abundant or less abundant
22 congeners on the right. And then below
23 that is the effluent; what happens after
24 the treatment process. What's actually

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1 being released from the wastewater
2 treatment plant into the river?

3 And what's interesting is, first
4 of all the two don't look the same. And
5 the reason for that is that this water
6 treatment plant is built under a really
7 high level of treatment. So there's
8 almost no solids coming out of this
9 plant. So anything that's sticking to a
10 solid particle is getting stripped away.
11 And the only thing that's left is the
12 stuff that's dissolved.

13 And the one PCB congener that is
14 now dominant in the effluent is PCB-11,
15 which is the one that comes from
16 pigments. And so this is a problem for
17 the City of Spokane, or the County of
18 Spokane, because they can go after the
19 Aroclor-type sources. They're one of the
20 cities suing Monsanto, for example. They
21 can try to remove all transformers and
22 capacitors. You know, they can try to do
23 a lot of things to remove the Aroclor-type
24 PCBs from their system. But that's not

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1 their main problem. Their main problem is
2 PCB-11 for pigments; and what are they
3 going to do about that. That's quite
4 difficult, because people are always going
5 to use color-printed, you know, paper;
6 and they're always going to wear printed
7 clothing. And they're always going to have
8 these pigments in their system. There's
9 not much that Spokane County can do about
10 their worst PCB problem.

11 This is a graph that's trying to
12 summarize what I've seen across several
13 different watersheds. So on the left,
14 you have the New York-New Jersey Harbor.
15 Next to that, the Delaware River; and
16 then the Portland Harbor superfund site.
17 And the Green-Duwamish River -- the
18 Green-Duwamish River runs through Seattle
19 into the Puget Sound. And the point here
20 is that some of these places, like,
21 especially, like the Green-Duwamish River,
22 you see that you've got the green, the
23 blue, and the purple bars. Those are all
24 Aroclors. So the Green-Duwamish River

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1 is totally contaminated by Aroclors.

2 And that's kind of what I would
3 have expected from the rest of the world,
4 too. And that's roughly true for the
5 Portland Harbor; although the Portland
6 Harbor also has a lot of dechlorination
7 happening which shows up in the water
8 column. But then you get to the Delaware
9 River. We're moving, you know, right to
10 left. You get to the Delaware River, and
11 you see the big black bar. That big black
12 bar is due to the production of titanium
13 dioxide at a plant in Edgemoor, Delaware.
14 So that's a non-Aroclor source of PCB
15 sediment. That's more than half of all the
16 PCBs in the sediment coming from non-Aroclor
17 source of PBCs.

18 So I hammer on these things. And
19 a lot of people are probably saying, why
20 do we need to learn about non-Aroclor
21 sources. They're not a big deal. Well,
22 they are. In some places, they're a very
23 big deal. In the Delaware River, they're
24 a very big deal. The Upper Hudson River

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1 is more typical, where most of what you're
2 finding in the Upper Hudson River is
3 related to Aroclors. But there are some
4 places in the world where these
5 non-Aroclor PCB sources are very important.

6 So what do you do about the cleanup of
7 PCBs? This is very tough. There's a lot
8 you can do, in terms of prevention. And,
9 for example, the Great Lakes, by National
10 Toxic Strategy, one of their main things
11 is to remove and replace PCBs containing
12 electrical equipment, especially
13 transformers. That's the big thing that
14 they're doing in Chicago. They're doing
15 this in New York City. A lot of places
16 all around the country are just trying to
17 remove known sources, you know, stockpiles
18 of PCBs in their electrical grid.
19 Unfortunately, that mostly gets landfilled,
20 but, you know, you do what you can.

21 You can also try to prevent sediment
22 that has PCBs on it from ever getting to
23 the waterways. So, for example, that's
24 one of the reasons why that wastewater

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1 treatment plant in Spokane was built to
2 have such great solid removal, because
3 they just wanted to get all the PCBs out
4 so that the solids never even reached the
5 river; and, therefore, the PCBs stuck to
6 the solids never reached the river.

7 There's also other things going on,
8 trying to, you know, have storm water
9 management so that the particles get
10 filtered out of storm water before it
11 runs into the waterway. You might be
12 familiar with a lot of the rain gardens,
13 and things like that, that people use.

14 In many cities, for example, I
15 know in Camden, New Jersey, there was a
16 big track down study where they were
17 trying to figure out what are the PCB
18 sources in the City of Camden; to find
19 them and cap them off. Those have had
20 mixed success.

21 In terms of remediation, usually
22 if you're talking about PCB contamination
23 in a waterway, the only cost-effective
24 solution is to dredge the sediments; you

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1 know, to remove it from the river, mix it
2 with cement, pack it into a railcar and
3 send it to a hazardous waste landfill.
4 That's what they did in the Upper Hudson.
5 That's what they did in the Passaic
6 River. That's what -- it ends up being
7 commonly done.

8 If you can't remove all the PCBs
9 in the sediment, which you can't, there's
10 always going to be some PCBs containing
11 sediment left over. One thing to do is
12 try to add some absorbant, like granular-
13 activated carbon, which is basically just
14 soot, like black carbon. If you add that
15 to the sediment, the PCBs absorb to it
16 really strongly. And then even though
17 PCBs are still there in the sediment,
18 they can't get out to effect the BYOTA
19 (ph) -- the worms and the clams and the
20 fish. So they get sequestered and they
21 don't go anywhere. So that's another
22 option that people have tried. Okay.
23 So I'm going to close my talk here by
24 just spending a couple minutes talking

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1 about the issue of PCBs in schools.

2 There's a picture here of Cindy
3 Crawford talking about PCBs in schools.
4 She's led some celebrity status to the
5 issue, because this was happening in the
6 Malibu High School, which is where her
7 children were going. So she got very
8 active in the issue.

9 So many of the public buildings
10 that were constructed in the 1960s and
11 1970s had PCBs in their building materials.
12 Mostly, this was in the form of Aroclor
13 1242 -- excuse -- 1254, although some of
14 the other Aroclors were used as well.
15 And they were in the caulk, especially
16 caulk, like around windows and masonry
17 joints.

18 Remember, all these buildings, a
19 lot of them were cinderblock. And in
20 between the cinderblocks they would have
21 the caulk joints; so that kind of caulk.
22 They were in the fluorescent light
23 ballasts, and sometimes the adhesive that
24 stuck the carpet to the floor. You know

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1 all kinds of these building materials
2 could have PCBs in them. And from what I
3 have heard and understand, PCBs were
4 mixed into the caulk and into the building
5 material on site.

6 So some construction worker, who
7 probably doesn't have any training or
8 know anything about PCBs, was told to mix
9 PCBs with the caulk; you know, make it
10 half and half. Right? Something like
11 that. So they would mix the stuff together
12 and then they would go caulk everything.
13 And at the end of the day, you would see
14 you've got a little bit left in your
15 bottle of PCBs, and you don't really want
16 to do anything with it, so you just dump
17 it on the ground. And, unfortunately,
18 that means that the soil around many of
19 these schools is pretty contaminated.

20 And I know that that turned out to
21 be the case around the Malibu school.
22 And we've seen that the PCBs can volatilize
23 into the air. And so then they get into
24 the dust, and go, you know, from the

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1 caulk, to the air, and then onto the
2 dust. And then the dust is all over in
3 the HVAC system and all of the ductwork.
4 So the PCBs are moving around the school.
5 I've seen instances where you've
6 had buildings where half the building was
7 built in the 1950s, and the other half
8 was built in the '70s. But the new
9 building has sort of contaminated the old
10 building because of the movement of air
11 and dust throughout the whole structure.
12 And so humans, and especially in this
13 case, of course, school children, but
14 also their teachers and administrators,
15 they can be exposed to PCBs by touching
16 the contaminated material, the dust and
17 the soil, and rolling around in the dirt
18 on the playground. And there's a study
19 -- really recent study that came out that
20 shows that for children, inhalation -- if
21 they were in a contaminated school,
22 inhalation can become an important route
23 for which they can become exposed. And,
24 of course, children, in general, are always

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1 more at risk for the kinds of
2 developmental problems that come from
3 chemical exposure, because their immune
4 systems are developing. They're young.
5 So they are more likely to show the toxic
6 effects of these chemicals than older
7 people; adults.

8 So the EPA -- you can go on their
9 website. They've got some advice. One
10 of the things they say is, well, replace
11 all your old lighting systems. And that's
12 great. Because if you replace lighting
13 systems that are so old that they've got
14 PCBs in them, you're almost, by definition,
15 going to be replacing them with something
16 much more energy-efficient. So this is a
17 great thing, regardless. And, in fact,
18 the New York City school systems have
19 decided to do this. They're spending
20 millions of dollars upgrading their
21 lighting. So that's good.

22 Reduce the potential for PCBs in
23 the indoor air by maintaining a proper
24 ventilation system, which means cleaning

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1 your air ducts. And then until it can be
2 safely removed, limited exposure, by
3 keeping children away from it.

4 So imagine how fun that is trying
5 to keep children away from caulk in their
6 school. Yeah. Good luck with that.

7 Wash the children's toys off. I
8 have kids. I know. Their toys were
9 never cleaned. I know that's true.

10 Washing their hands with soap and
11 water. I know it's not easy to get kids
12 to do that. You're expecting teachers to
13 wipe down all the surfaces with wet cloths
14 every day. You know, some of these
15 things, to me, sound a little
16 unrealistic. But that's EPA's advice
17 about what to do in the school system.

18 The actual response, as I mentioned,
19 in New York City -- the city is going to
20 spend 708 million dollars retrofitting
21 all of their lighting to remove these
22 light ballasts over the next ten years.
23 Another big place this has become an
24 issue is Lexington, Massachusetts. In

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1 Lexington, what they did is, they tried
2 to keep cleaning and re-testing. They
3 kept cleaning the air ducts and cleaning
4 the school and re-testing. And so they
5 would clean the air ducts, and they would
6 test the air quality immediately afterwards.
7 And the PCB levels would be way down, and
8 they'd be very happy. And then they'd
9 come back three months later and the PCB
10 levels had gone back up again. And so
11 they finally realized this just wasn't
12 going to work. They can clean forever,
13 and they would never be able to get all
14 the PCBs out of the school.

15 So in the end, Lexington had to
16 build a new school. And we all know how
17 difficult it is to raise the money to get
18 that to happen. So Lexington is also
19 suing Monsanto for the cost of the new
20 school.

21 And so this is quote that I think
22 really sums it up. If the system can't
23 fix a problem in Malibu, California,
24 where Cindy Crawford's kids were going,

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1 then it's hopeless for places like
2 Louisiana or Arkansas or rural Ohio,
3 where you don't have the money. You're
4 not necessarily environmentally aware.
5 You don't have celebrities like Cindy
6 Crawford to raise awareness. And it
7 becomes very, very difficult to figure
8 out what to do about this.

9 And I looked up a couple of
10 statistics. As of 2012, the average age
11 of a school building in the United States
12 was 44 years, which means the average
13 school in America was built in 1968, and,
14 therefore could very well have PCBs in
15 it. Of course, all these schools were
16 being built in the '60s and '70s when all
17 of the baby boomers, you know, were starting
18 to go off to school, off to elementary
19 school and off to high school.

20 And in case you were not aware,
21 school buildings are more than 99 percent
22 funded at the state and local level. So
23 if you have a problem with PCBs in your
24 school, it's your problem. The federal

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1 government
2 is not going to help. So that's
3 obviously a big flaw in the design here.

4 Okay. So these are some of the
5 references that I cited throughout the
6 talk. I hope that you've learned something
7 interesting. I pretty much nailed my
8 time target. It's 12:48 -- 12:58 --
9 excuse me, right now. And I'm happy to
10 stay here and answer a few questions, if
11 anybody has anything they'd like to ask.

12 Yes. Okay. So we have a question
13 here about: Does added chlorine to the
14 wash water or drinking water supply allow
15 free chlorine to make any PCB congeners
16 that are present more hazardous?

17 Not that I know of. In order for
18 the chlorine in the drinking water to
19 produce PCBs, you need a pretty good
20 amount of chlorine, and you need a lot of
21 biphenyl as a starting material. And in
22 drinking water, you just don't have that
23 much. So as far as I know, that is not --

24

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1 it's not an issue of PCBs being formed
2 inadvertently from the chlorination of
3 drinking water.

4 Another question? That's it? Okay.

5 That was our only question. So we're
6 done here. Thank you again for spending
7 some time with us and learning about
8 PCBs. And, once again, our thoughts go
9 out to the people of Puerto Rica and our
10 partners down there. And we hope that
11 anything that we can do to help them
12 recover from Hurricane Marie, we're
13 definitely going to do.

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